First data on the freshwater fish fauna of Calabria (Southern Italy)

Journal:	*Italian Journal of Zoology*
Manuscript ID:	TIZO-2010-0155
Manuscript Type:	Original Paper
Date Submitted by the Author:	28-Sep-2010
Complete List of Authors:	Gallo, Luana; Università della Calabria, Dipartimento di Ecologia Lucadamo, Lucio; Università della Calabria, Dipartimento di Ecologia Mezzotero, Antonietta; Università della Calabria, Dipartimento di Ecologia Battegazzore, Maurizio; ARPA Piemonte Morisi, Angelo; ARPA Piemonte Fenoglio, Stefano; Università del Piemonte Orientale, Dipartimento Scienze Ambientali e della Vita
Keywords:	freshwater fish, Calabria, ichthyology, allocthonous species

First data on the freshwater fish fauna of Calabria (Southern Italy)

LUANA GALLO [1*], LUCIO LUCADAMO [1], ANTONIETTA MEZZOTERO [1], ANGELO MORISI [2], MAURIZIO BATTEGAZZORE [2], STEFANO FENOGLIO [3]

[1] Dipartimento di Ecologia, Università della Calabria, Via Pietro Bucci cubo 4B, I-87036 Arcavacata di Rende (Cs), Italy. E-mail: luana.gallo@unical.it

[2] ARPA Piemonte, Via Vecchia di Borgo S. Dalmazzo 11, 12100 Cuneo, Italia

[3] Di.S.A.V. Università del Piemonte Orientale, Via T. Michel 11 15121Alessandria, Italy

* Correspondence: L. Gallo, di Ecologia, Università della Calabria, Via Pietro Bucci cubo 4B, I-87036 Arcavacata di Rende (Cs), Italy. E-mail: luana.gallo@unical.it

Abstract

Studies on freshwater fish presence and distribution in southern Italy are scarce and sporadic, and in particular, ichthyological information regarding Calabria lotic systems is practically inexistent. Aim of this study is to provide information about the present status of freshwater fish fauna in some of the most important lotic systems of Calabria. Ichthyological samplings were performed in fifty-four stations along fifteen Calabrian rivers. Sixteen fish species belonging to eight families were found, and their presence and distribution were discussed on the basis of biogeographical and ecological considerations. Results indicate that freshwater fish fauna of the area has been dramatically altered by recent and contemporary introduction of allocthonous species, mainly originating from the Po plain catchments, representing a prime example of faunistic transformation of a Mediterranean area.

Keywords: Freshwater fish, Calabria, ichthyology, allocthonous species.

Introduction

The natural distribution of native fish fauna in Italy is the result of complex paleogeographic and paleoecologic processes. According to the salinity tolerance, Bianco (1995a) recognized four categories of freshwater fish in Italy: 1) Primary, taxa that originated and spread only in freshwaters (such as Cypriniformes); 2) Primary-like, freshwater species of marine origins (such as many Gobiidae); 3) Secondary taxa, that are euryhaline and can survive in marine environments (such as Cyprinodontidae); 4) Peripheral, recent marine derivates and diadromous taxa (such as Salmonidae, Gasterosteidae and Acipenseridae). Dispersal capacity changes in these groups, and in particular primary freshwater fishes represent an important group for biogeographical studies: these fish tolerate only low salt concentrations and are unable to disperse through marine environments, so that their distribution is strictly related to the history of hydrographic systems. In facts, primary fish can't diffuse from a river network to another via sea, while secondary and peripheral fish can move in this way. On the basis of the distribution of indigenous taxa, Bianco (1990) individuated two distinct ichthyogeographic regions in the Italian peninsula, with many endemisms that possibly were isolated since the Messinian Age (about 5 million years). The Padano-Venetian district contains basins of middle and upper Adriatic sea to the north of the river Vomano, while the Tuscano-Latium district includes Serchio, Arno, Ombrone and Tevere basins. For paleogeographic reasons, southern Italian basins were isolated from the rest of the peninsula and are with few or no native primary freshwater fishes, and rivers and streams of this area were colonised mainly by saline-tolerant species, coming from the Mediterranean. Unfortunately, this picture dramatically changed because anthropic introductions has radically altered the original distributions of freshwater fish in almost all Italian basins (Gandolfi et al. 1991; Zerunian, 2002).

At present, studies on freshwater fish presence and distribution in southern Italy are scarce and sporadic, and in particular, ichtyological information about Calabria lotic systems are practically inexistent. In particular, there are a few isolated reports, regarding the presence of single species in particular Calabrian rivers (e.g.: Bianco, 1981; Bianco & Recchia 1983).

The aim of this study is to provide information about the present status of freshwater fish fauna in some of the most important lotic systems of Calabria, analysing historical and ecological reasons of their presence and distribution.

Materials and Methods

This study collates data from some ichthyological surveys in Calabria (Southern Italy). Fifty-four sites belonging to fifteen lotic systems were analysed to investigate presence and distribution of fish (Figure 1). The examined rivers (and stations) were: Abatemarco (AB1-AB2), Coscile (CO1-CO5), Crati (C1-C5), Esaro (ES1-ES3), Lao (L1-L3), Lipuda (LI1-LI2), Neto (NE1-NE5), Ampollino (AM1), Lese (LE1-LE2), Vitravo (VI1-VI3), Rosa (RS1-RS2), Savuto (SV1-SV4), Tacina (TA1-TA7), San Antonio (SAN1-SAN2), Soleo (SO1-SO3), and Trionto (TR1-TR4). More information on the chemical and biological characteristics of major Calabrian rivers are reported in Lucadamo et al. (2008). The location of each sampling station within a river reach was selected in the field based on representativivity and accessibility: a variety of habitat types (pools, riffles and runs) was sampled in each occasion. During low flow conditions, each stations was electrofished by passing once upstream, searching from one bank to the other, following the methods outlined by Bohlin et al. (1989) for a total length of almost 200 m. Single-pass qualitative electrofishing was conducted using a backpack electric fishing machine (SCUBLA ELT60, operated at 25-100 Hz and 300/550 V, depending on the water conductivity). Single pass electrofishing is infact a suitable and usual method for assessing distribution of freshwater fish in small and medium size lotic environments (Jowett & Richardson, 1996; CEN, 2003; Maceda-Veiga et al. 2010). Once collected, fish were identified, counted, then returned to the river; some species, mainly Salmonidae, were also measured (standard length and weight), and sorted them in size classes. Taxonomic nomenclature used is consistent with the checklist of the species of the Italian fauna (Stoch 2004). Main abiotic parameters (altitude, streambed width, water depth, conductivity, pH, C.O.D., B.O.D.) were recorded and the biological quality of the site was calculated using macroinvertebrate assemblage composition and structure (I.B.E. index, Ghetti 1997).

In order to identify the faunal similarity of stations, cluster analysis using the Bray-Curtis similarity coefficient (Bray & Curtis 1957) was applied, and a similarity dendrogram was produced using Biodiversity Pro software. Canonical Correspondence Analysis (CCA), a

widely used method for direct gradient analysis, was employed in order to analyse relationships between fish distribution and the measured environmental parameters, by using SYNTAX statistical program.

Results

In this study, 54 stations were sampled to assess fish presence. List and distribution of fish species are reported in Table 1.

Fish species

A total of sixteen fish species was found: eight belonging to the family Cyprinidae, two to Salmonidae, one to Anguillidae, one to Ictaluridae, one to Mugilidae, one to Blennidae, one to Cobitidae and one to Poecilidae. In the following paragraphs, information on each species is provided.

- *Anguilla anguilla* Linnaeus, 1758. Eel represents one of the few native species of the area (Rogliano 1963). These catadromous fish have been found in many lotic systems of the area, such as Crati, Lao, Abatemarco, Coscile, Neto, San Antonio, Soleo and Tacina, also if their present distribution is probably affected by dams and other artificial elements, that can restrict access to upstream river areas.

- *Rutilus rubilio* (Bonaparte, 1837). This species is probably native of central Italy. Costa (1850) found no fish attributable to this particular and characteristic cyprinid species in Calabria, so we agree with Bianco and Taraborelli (1984) that *R. rubilio* has been introduced in Calabrian inland waters. These same authors also reported that *R. rubilio* can hybridize with other cyprinids (e.g., a hybrid *R. rubilio* x *L. cephalus* was found in the Crati river near Terranova di Sibari).

- *Barbus plebejus* (Bonaparte, 1839) is endemic to the Padano-Venetian district (Bianco 1995b, 2003), but it was trans-introduced in many rivers in central and southern Italy. In our study area, this species was only found in the Crati basin (Crati, Esaro and Coscile rivers) as a result of a probably recent local and successful introduction.

- *Alburnus alburnus alborella* (De Filippi, 1844), native of the Padano-Venetian district, is now spread through all of Italy, including Calabria. Bianco and Taraborelli (1984) suggested that this species was introduced in Calabria, and particularly in area of the Sila mountains, not for direct fishing but as a prey species for introduced trout.

- *Leuciscus cephalus* (Linnaeus, 1758). This species is one of the most important examples of trans-introduced fish in Italy: characterised by a wide range of tolerance for different environmental factors, *L. cephalus* is able to withstand certain levels of pollution. In our study this species has been found in many lotic systems, from both Ionian and Tirrenian catchments. Recently, a new subspecies of chub from the Savuto river has been described, named *Leuciscus ruffoi* Bianco & Recchia, 1983, but its taxonomical position still remains unclear. Our samplings in the Savuto river detected an high incidence of mycosis and health problems in the local chub population, presumably due to chemical alterations of the water.

- *Scardinius erythrophtalmus* (Linnaeus, 1758) is a cyprinid known for Padano-Venetian and Tusco-Latium district. Its presence in southern aquatic systems is due to recent introductions. The rudd is a typical lentic cyprinid, and its presence in running waters is very sporadic: rudds in the mountainous reach of the Savuto river surely come from a nearby, upstream artificial lake.

- *Carassius carassius* (Linnaeus, 1758). This allocthonous species is quite common in northern Italy, but is rare in central and southern basins (Forneris et al. 1990). Our study demonstrates that *C. carassius* is present in many lowland Calabrian running water systems, such as the Crati, Tacina and Coscile.

- *Cyprinus carpio* Linnaeus, 1758. This species was a prime example of invasive freshwater taxon, because it was diffusely introduced in Italy since the Roman period from the Danube basin (Balon 1995). In Calabria the species seems to be present in many high-order, lowland habitats, such as the Neto, Tacina and Crati.

- *Tinca tinca* (Linnaeus, 1758). This species was only found in the lower reach of the Tacina river, and its presence is surely due to recent introductions for sport-fishing purposes.

- *Cobitis taenia* Linnaeus, 1758. Bianco and Taraborelli (1984) signalled the presence of this species in the Ampollino lake and in the Savuto river, suggesting that the introduction of loach was made for the purpose of foraging introduced trout. Our study confirms the presence of this species in the Savuto river, and for the first time reports its presence in some other Calabrian lotic systems.

- *Salmo (trutta) trutta* Linnaeus, 1758. In the Mediterranean area, brown trout is considered a freshwater species of recent marine origin (Bianco 1995a). Fossil evidences indicate that trout were present in southern Italy since the Pleistocene (Durante 1978). The typical

Mediterranean trout, *Salmo (trutta) macrostigma* Duméril 1858, is a salmonid species occurring in inland water habitats in northern Africa, southern Europe, western Asia and Anatolia (Gandolfi et al. 1991). This species is supposed to be the characteristic trout of southern Italy, including Calabria. In our samplings, a very puzzling situation was found: some specimens from few populations (found for example in the upper Lese, San Antonio and Lao) have phenotypic characters that may be referred to *macrostigma* type, such as the permanence of parr marks in the adults. Unfortunately, great part of populations are clearly derived by recent or contemporary introductions, with trout showing in great part Atlantic phenotypic traits. Our findings confirms for Calabria the thesis reported in Schöffmann et al. (2007) that, while in the past century many rivers of southern Italy were stocked with hatchery-reared brown trout originating from the northern part of the Mediterranean basin (Sommani 1969), in recent time the majority of introduced trout have derived from hatchery stocks of Atlantic origin (Ketmaier & Bianco 2004).

- *Onchorynchus mykiss* (Walbaum, 1792). Rainbow trout is probably the most widely introduced fish species in the world (Fausch 2008). Our findings suggest that very few populations are present in Calabria, with no traces of self-sustaining capacity, so that these populations seems to be exclusively sustained by continuous releases.

- *Ictalurus* sp. To our knowledge, this is the first citation of the presence of the American catfish in Calabrian inland waters. This species seems to be very sporadic, and its presence due to occasional introductions in the lower part of the Crati river.

- *Gambusia holbrooki* Girare, 1859. This Poecilid, native of Atlantic areas of the United States, has been introduced in Calabria for the first time in 1928-31, in the context of a complex anti-mosquito campaign (Paladino-Blandini 1933). This species seems to be acclimated in some lowland, slow running water systems (such as the inferior parts of Tacina, Neto and Lese rivers).

- *Lipophrys fluviatilis* (Asso, 1801) This Blennidae is a peri-Mediterranean freshwater fish with benthic habits, autocthonous for Calabria, that is considered as a Messinan survivor derived by *Lipophrys pavo* (Zander 1973).

- *Liza ramada* (Risso, 1826): this species, such as *Mugil cephalus* and other Mugilidae, is quite widespread in Mediterranean costal waters, and often penetrate in freshwater systems. *L. ramaza* was found in some lowland stations of Ionian catchments.

Stations and lotic systems

On the whole, nine stations resulted fishless, eleven stations had only one species and only four presented a relatively rich fish community, with a total of seven species. Comments on community richness can be made only considering the huge number of allocthonous species: in facts, the number of species in a stream reach depends not only on environmental characteristics but also on the history of introductions that took place in the area. Bray-Curtis similarity analysis showed two distinct and major clusters (Figure 2). Headwaters of Abatemarco, Coscile, Crati, Lese, Rosa, San Antonio, Savuto, Soleo, Trionto and Vitravo contained stations characterised by the presence of *Salmo trutta*: trout were found as unique fish taxon, or in association with *A. anguilla*, or more rarely with *O. mykiss* or some accompanying cyprinids, mainly *L. cephalus* and *B. plebejus*. The other most important cluster is basically characterized by stations lacking Salmonidae, with various assemblages of Cyprinidae (for the most part including *L. cephalus*, *R. rubilio*, *C. carpio*) and other species. Within this group, two clusters can still be recognized: a first cluster (including mainly lowland stations of the Neto hydrographic network, plus the final segment of Tacina) is characterised by the presence of *A. anguilla*, *L. fluviatilis*, *G. holbrooki*, while the other (including stations from Crati network, plus few others from Neto and Tacina networks) is characterised by the presence of *B. plebejus*, *C. carassius*, and *L. ramada*. This difference in fish fauna composition can be related to different episodes of anthropic introduction and to some environmental differences among stations (mainly regarding streambed width, water column depth, conductivity). The final part of the Trionto river is isolated in the cluster analysis: this station corresponded to a peculiar environment, called '*fiumara*'. Water presence in these environments is intermittent and seasonal, so that in these and similar environments, biological communities are constituted by well adapted species (Fenoglio et al. 2006). The presence of *R. rubilio* in this station is limited to few deep pools, and can be considered occasional and ephemeral.

The Canonical Correspondence Analysis (Figure 3) indicates that both native and alien species are located on environmental gradients determined largely by altitude and streambed characteristics: in particular, Salmonidae are only present in high, low order environments, while the presence of *S. erythrophtalmus* in two stations seems not to be correlated with any biological or environmental parameters, but seems the result of punctual releases.

Discussion and conclusions

This study is probably the first structured attempts to analyse the presence and distribution of freshwater fish in lotic systems of Calabria. Analysing data from fifteen rivers, from both Ionian and Tyrrhenian slope, a preliminary but quite comprehensive picture of the current situation was obtained. The present distribution of freshwater fish in Calabria is the result of recent events, mostly related to human interventions. The displacement of fish in new hydrographical basins has been a common practice for a long time: Romans were the first to breed and introduce Carps (*Cyprinus carpio*) from the Danube to the Mediterranean area for breeding purposes, and the tradition of the "piscinae" was expanded in monasteries throughout Europe in the Middle Age (Balon 1995). Another interesting example of fish introduction is Rainbow Trout (*Onchorynchus mykiss*): this species is probably the most widely introduced fish species in the world, released in almost all continents (except Anctarctica) for fishing purposes, with great impacts on local fauna (Cambray 2003). But, while introduction of a single species can represent a great but also localised and punctual threat to biodiversity, a totally different scenario is represented by the complete change of the fish fauna of an entire area, as occurred in Calabria. Few species (such as Eel and Trout) represented, according to Rogliano (1963) and Bianco (1987) the only freshwater fish present in great part of Calabria (for example in the running waters of the Sila mountainous system), where many streams were even devoid of fish fauna. In facts, Bianco (1987) reported that Cyprinid distribution in Southern Italy was limited to the rivers to the north of the line connecting Sinni to Alento. This original situation has dramatically changed because of massive introduction of allocthonous species. The official and unofficial introduction of "white fishes" caused a process of 'padanization' (*sensu* Cambray 2003) in most basins of Calabria: the transplantation of native species from north to southern Italy is a phenomenon that began more than forty years ago and completely altered the ichthyological fauna of the area. Human introductions altered not only biodiversity at community level, but also altered genetic pools at population level: in particular, allocthonous trout strains dramatically altered the genetic characteristics of native populations. In fact, as reported by Nonnis Marzano et al. (2003) during the last century, domesticated strains of *S. (trutta) trutta* (also known as morpha *fario*) have been transferred from northern Italy to most of southern

freshwater basins without considering the presence of autochthonous populations of *S. (trutta) macrostigma*. This practice has been then subsequently replaced by the introduction of trout of Atlantic origin, as evidentiated by our study.

At present, freshwater fish distribution in Calabria reflects some main patterns, such as the history of local introductions and naturalisations and ecological and life-history characteristics of each species. Interestingly, while northern and central Italian basins experienced a diffuse 'danubianization' and 'globalisation' of their ichtiological communities, the Calabrian fish fauna has been altered by massive introduction of Padano-Venetian species.

Acknowledgements

We are grateful to many students from Ecology department of Arcavacata di Rende (CS) for help in field samplings.

References

- Balon EK. 1995. Origin and domestication of the wild carp, *Cyprinus carpio*: from Roman gourmets to the swimming flowers. Aquaculture 129:3-48.
- Bianco PG. 1981. Areale italico, rinvenimento in Calabria e origini delle popolazioni mediterranee di *Gasterosteus aculeatus*. Bollettino del Museo civico di Storia naturale di Verona 7:197-216.
- Bianco PG. 1987. L'inquadramento zoogeografico dei pesci d'acqua dolce d'Italia e problemi determinati dalle falsificazioni faunistiche. II Convegno Nazionale A.I.I.A.D., Torino, 5-6 June 1987, Torino.
- Bohlin T, Hamrin S, Heggberget TG, Rasmussen G, Salveit SJ. 1989. Electrofishing – theory and practice with special emphasis on salmonids. Hydrobiologia 173:9-43.
- Bianco PG. 1990. Vanishing freshwater fishes in Italy. Journal of Fish Biology 37:235-237.
- Bianco PG, 1995a. Mediterranean endemic freshwater fishes of Italy. Biological Conservation 72: 59-179.
- Bianco PG. 1995b. A revision of Italian species of *Barbus*. Ichthyological Exploration of Freshwaters 6:305-324.
- Bianco PG, Recchia F. 1983. The Leuciscinae of the *squalius* species complex in Italy (Pisces, Cyprinidae). Italian Journal of Zoology 50:15-19.
- Bianco PG, Taraborelli T. 1984. Il *Leuciscus lucumonis* Bianco, 1983 nel bacino del Tevere e altri reperti di pesci d'acqua dolce in Italia (Pisces Cypriniformes). Natura 75:110-116.
- Bray JR, Curtis JT. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27:325-349.
- Cambray JA. 2003. Impact on indigenous species biodiversity caused by the globalisation of alien recreational freshwater fisheries. Hydrobiologia 500:217-230.
- CEN. 2003. Sampling of fish with electricity. European standard – EN 14011:2003. Brussels: European Committee for Standardization.
- Costa OG. 1850. Fauna del Regno di Napoli. Pisci, parte prima. Napoli: Azolino.
- Durante S. 1978. Note on *Salmo trutta* in the Pleistocene of Praia a Mare (Southern Italy). Quaternaria 20:117-121.
- Fausch KD. 2008. A paradox of trout invasions in North America. Biological Invasions 10:685-701.

- Fenoglio S, Bo T, Bosi G. 2006. Deep interstitial habitat as a refuge for *Agabus paludosus* (Fabricius) (Coleoptera: Dytiscidae) during summer droughts. The Coleopterist Bulletin 60:37-41.
- Forneris G, Paradisi S, Specchi M. 1990. Pesci d'acqua dolce. Udine: Lorenzini ed.
- Gandolfi G, Zerunian S, Torricelli P, Marconato A. 1991. I pesci delle acque interne italiane. Roma: Istituto Poligrafico e Zecca dello Stato.
- Ghetti PF. 1997. Manuale di applicazione Indice Biotico Esteso (I.B.E.). Trento: Provincia Autonoma di Trento Ed.
- Jowett IG, Richardson J. 1996. Distribution and abundance of freshwater fish in New Zealand rivers. New Zealand Journal of Marine and Freshwater Research 30:239-255.
- Lucadamo L, De Filippis A, Mezzotero A, Vizza S, Gallo L. 2008. Biological and chemical monitoring of some major Calabrian (Italy) rivers. Environmental Monitoring and Assessment. 146:453-471.
- Maceda-Veiga A, Monleon-Getino A, Caiola N, Casals F, De Sostoa A. 2010. Changes in fish assemblages in catchments in north-eastern Spain: biodiversity, conservation status and introduced species. Freshwater Biology 55:1734-1746.
- Nonnis Marzano F, Corradi N, Papa R, Tagliavini J, Gandolfi G. 2003. Molecular evidence for introgression and loss of genetic variability in *Salmo (trutta) macrostigma* as a result of massive restocking of Apennine populations (Northern and Central Italy) Environmental Biology of Fishes 68:349-356.
- Ketmaier V, Bianco PG. 2004. Monitoraggio genetico e ibridazione tra popolazioni atlantiche e mediterranee di *Salmo trutta* in Abruzzo e Campania. XIII Congresso Nazionale della Societa` Italiana di Ecologia. 8–10 September 2003, Como.
- Rogliano G. 1963. Sila (Saggio di geografia regionale). Opera per la valorizzazione della Sila. Cosenza: Tipografia Eredi Serafino.
- Paladino-Blandini A. 1933. Ordinamento e primi risultati della lotta anti-anofelica generale in Calabria. Rivista Malariologica 12:118-195.
- Schöffmann J, Susnik JM, Snoj A. 2007. Phylogenetic origin of *Salmo trutta* L 1785 from Scicily, based on mitochondrial and nuclear DNA analysis. Hydrobiologia 575:51-55.
- Sommani E. 1969. Variazioni apportate all'ittiofauna italiana dall'attività dell'uomo. Bollettino Pesca Piscicoltura Idrobiologia 23: 49-166.

- Stoch F, editor. 2004. Checklist of the species of the Italian fauna. Version 2.0. Available: http://checklist.faunaitalia.it. Accessed Aug 2010 24.
- Zander CD. 1973. Evolution of Blennoidei in the Mediterranea sea. Revue des Travaux de l'Institut des Peches Maritime 37: 215-221.
- Zerunian S. 2002. Condannati all'estinzione? Biodiversità, biologia, minacce e strategie di conservazione dei pesci d'acqua dolce indigeni in Italia. Bologna: Il Sole 24 Ore Ed. Agricole.

Captions to figures

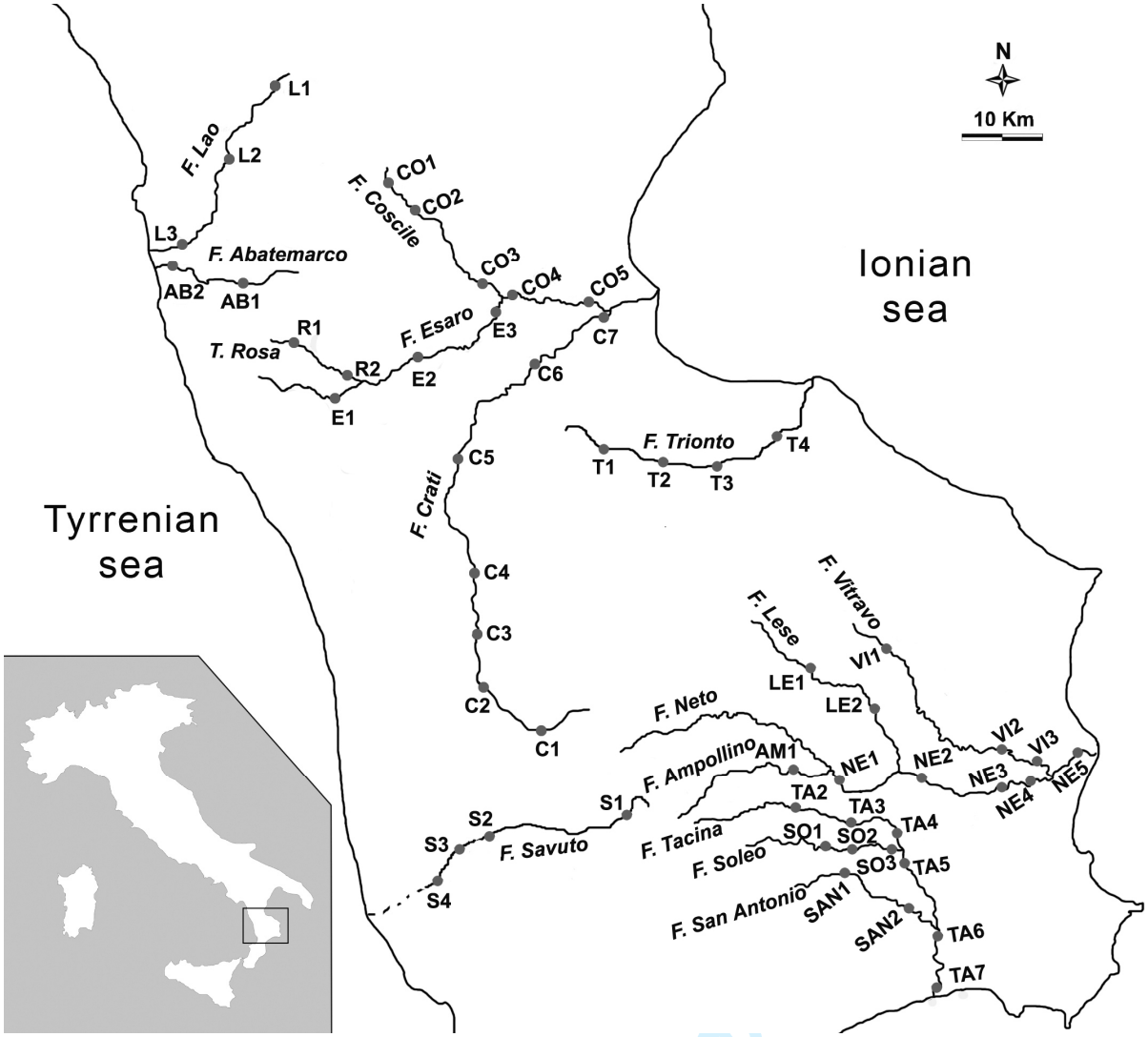
Fig. 1 : Main Calabrian lotic systems and sampling stations.

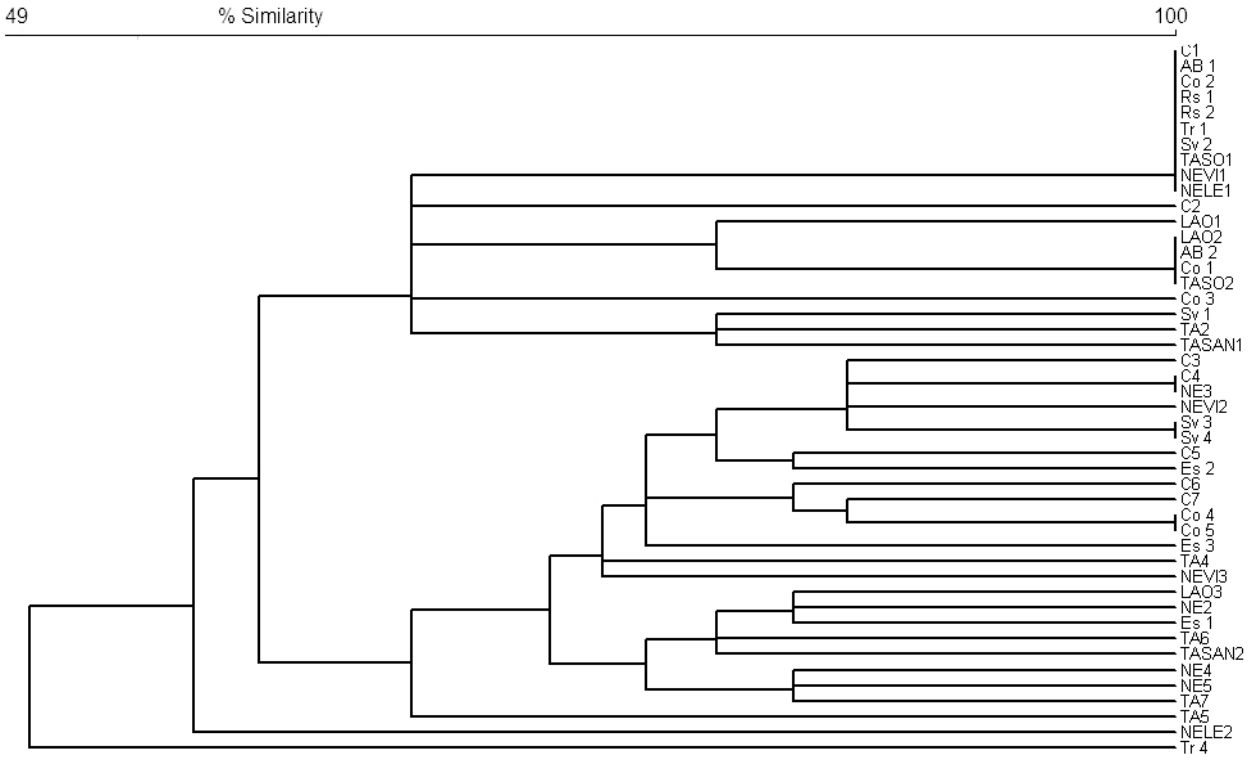
Fig. 2: Bray-Curtis similarity dendrogram regarding 54 freshwater fish sampling stations.

Fig. 3: Canonical Correspondence Analysis ordination of fish and main environmental characteristics in Calabrian lotic systems.

Table I: List of freshwater fish species collected in the sampling stations.

	Salmo trutta	*Leuciscus cephalus*	*Barbus plebejus*	*Carassius carassius*	*Anguilla anguilla*	*Ictalurus sp.*	*Liza ramada*	*Rutilus rubilio*	*Cyprinus carpio*	*Alburnus alburnus*	*Lipophrys fluviatilis*	*Scardinius erythrophtalmus*	*Cobitis taenia*	*Gambusia holbrooki*	*Onchorynchus mykiss*	*Tinca tinca*
AB1	X															
AB2	X				X											
C1	X															
C2	X	X														
C3		X						X	X							
C4		X						X	X	X						
C5		X	X			X		X	X	X						
C6			X	X			X	X	X							
C7		X	X	X	X	X	X	X								
Co1	X				X											
Co2	X															
Co3	X	X	X		X											
Co4		X	X	X	X		X	X	X							
Co5		X	X	X	X		X	X	X							
Es1	X	X						X		X	X					
Es2		X	X	X				X	X	X						
Es3		X	X		X		X	X		X						
LAO1	X				X					X						
LAO2	X				X											
LAO3		X			X			X		X	X					
NE2	X	X			X			X		X	X			X		
NE3		X						X	X	X						
NE4		X					X		X	X	X			X		
NE5		X			X		X		X	X	X					
LE1	X															
LE2										X			X	X		
VI1	X															
VI2		X						X	X				X			
VI3		X		X					X				X			
Rs1	X															
Rs2	X															
Sv1	X											X				
Sv2	X															
Sv3		X						X					X			
SV4		X						X					X			
TA2	X											X			X	
TA4		X		X				X					X			X
TA5								X		X			X			X
TA6					X			X	X	X	X					
TA7		X			X				X	X	X			X		
SAN1	X														X	
SAN2					X			X		X	X		X			
TASO1	X															
TASO2	X				X											
T1	X															
T4								X								


N
10 Km
Ionian sea
Tyrrenian sea
L1
L2
L3
F. Lao
F. Abatemarco
AB2
AB1
CO1
CO2
F. Coscile
CO3
CO4
CO5
R1
R2
T. Rosa
F. Esaro
E1
E2
E3
C7
C6
C5
C4
C3
C2
C1
F. Crati
T1
T2
T3
T4
F. Trionto
F. Vitravo
F. Lese
VI1
VI2
VI3
LE1
LE2
F. Neto
AM1
F. Ampollino
NE1
NE2
NE3
NE4
NE5
TA2
TA3
TA4
TA5
TA6
TA7
S1
S2
S3
S4
F. Savuto
F. Tacina
SO1
SO2
SO3
F. Soleo
SAN1
SAN2
F. San Antonio


49
% Similarity
100
C1
AB 1
Co 2
Rs 1
Rs 2
Tr 1
Sv 2
TASO1
NEVI1
NELE1
C2
LAO1
LAO2
AB 2
Co 1
TASO2
Co 3
Sv 1
TA2
TASAN1
C3
C4
NE3
NEVI2
Sv 3
Sv 4
C5
Es 2
C6
C7
Co 4
Co 5
Es 3
TA4
NEVI3
LAO3
NE2
Es 1
TA6
TASAN2
NE4
NE5
TA7
TA5
NELE2
Tr 4